

[0027] Figs. 9A and 9B are curvature profiles developed using the present invention illustrated in the correlation between the data developed using the present invention and the data generated by glide avalanche testing according to the prior art.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] Referring now to the drawings, and initially to Fig. 1, there is illustrated an exemplary disc drive designated generally by the reference numeral 20. The disc drive includes a plurality of storage discs 22a-d and a plurality of read/write heads 24a-h. Each of the storage discs 22a-d is provided with a plurality of data tracks to store user data. As illustrated in Fig. 1, one head is provided for each surface of each of the discs 22a-d such that data can be read from or written to the data tracks of all of the storage discs.

[0029] The storage discs 22a-d are mounted for rotation by a spindle motor arrangement 29, as is known in the art. Moreover, the read/write heads 24a-h are supported by respective actuator arms 28a-h for controlled positioning over preselected radii of the storage discs 22a-d to enable the reading and writing of data from and to the data tracks. To that end, the actuator arms 28a-h are pivotally mounted on a pivot 30 by a voice coil motor 32 operable to controllably rotate the actuator arms 28a-h radially across the disc surfaces.

[0030] Each of the read/write heads comprises a magnetic transducer 25 mounted to a slider 26 having an air bearing surface. As typically utilized in disc drive systems, the sliders 26 cause the magnetic transducers 25 of the read/write heads 24a-h to "fly" above the surfaces of the respective storage discs 22a-d for non-contact operation of the disc drive system, as discussed above. When not in use, the voice coil motor 32 rotates the actuator arms 28a-h to position each of the read/write heads 24a-h over a respective landing zone 58, where the read/write heads 24a-h come to rest on the storage disc surfaces.

[0031] A printed circuit board (PCB) 34 is provided to mount control electronics for controlled operation of the spindle motor 29 and the voice coil motor 32. The PCB 34 also includes read/write channel circuitry coupled to the read/write heads 24a-h, to control the transfer of data to and from the data tracks of the storage discs 22a-d. The

manner for coupling the PCB 34 to the various components of the disc drive is well known in the art.

**[0032]** Referring to Fig. 2, the data tracks extend across each surface of the storage discs 22a-d within a band having an inner diameter 40 and an outer diameter 32. The actuator arms 28a-h are controlled by the control electronics on the PCB 34, during read/write operations, to position the respective heads 24a-h over preselected data tracks within the bands defined by the diameters 40, 42. As should be understood, it is desirable for the outer diameter 42 of each effective disc storage surface to be as close to the outer diameter of the disc 22a-d, as possible, to provide a maximum radial width for storing data on the disc surfaces.

**[0033]** Referring now to Figs. 3a and 3b, there is illustrated an exploded end view of each of two types of disc ends commonly found in disc drives. In Fig. 3a, the slope of the surface of the disc 22 first moves upward, before turning downward at the outermost diameter of the disc 22. This is referred to as a "ski jump" type disc. In Fig. 3b, the surface of the disc 22 gradually tapers from a flat surface to a curved surface at the outermost diameter of the disc 22. In each of Figs. 3a and 3b, there is also shown a head 24, including air bearing surfaces comprising rails 46 and 48. The rails 46, 48 cause the head 22 to fly above the surface as shown in the drawing.

**[0034]** As known in the art, the fly height of the head becomes unstable when the rails 46, 48 and particularly outer rail 48, approaches the curved portions of the outer diameter of the disc 22. Thus, the outer diameter 54 of the data track band is placed at a suitable distance from the curved roll-off region to maintain an acceptable and stable fly height of the head 22 during read/write operations at the outer diameter 54. Due to manufacturing tolerances, the precise curved configuration for each particular disc will vary. Accordingly, it is desirable that the curved configuration, as shown in either Figs. 3a and 3b, for any particular disc 22 assembled into the drive 20 not impact fly height stability within a preselected maximum radius for the outer diameter 54. For these reasons, it is important not to locate the outer diameter track, for example, at location 55 ( Fig. 3a or Fig. 3b) within the roll-off region.

**[0035]** Fig. 4 shows, in block diagram form, an exemplary quality control test system according to the present invention for screening each disc 22a-d, prior to

assembly into the disc drive 20, to make certain that fly height stability is acceptable given the specifications of the disc drive in which the disc is to be used at the selected value for the outer diameter 42 of the data track band. To advantage, the testing according to the present invention can be performed by the quality control system on a substrate prior to sputtering to make a magnetic disc. In this manner, the suitability of a disc is determined at an early stage of a manufacturing process, and the sputtering process to make magnetic discs is performed using substrates that are already shown acceptable in respect of fly height stability.

**[0036]** Given the need to accurately detect from disc to disc the point at which such roll-off occurs that the fly height of the slider becomes unstable, as well as the desire to do so in a non-destructive manner, as compared to the destructive testing which is done in the glide avalanche approach, the present invention has been developed. As a first step, a slope scan type of instrument, such as a profilometer 100, shown schematically in Fig. 5A, will be utilized. This comprises at least a laser or equivalent source 102 and detector 104. The output of the laser 102 can be directed to each track, with the reflection off the track being directed to a detector 104 so that the slope angle  $\theta$  of each track of the outer region of the disc can be accurately detected. While using this or a similar device, the disc is rotated past the profilometer 100 as shown in Fig. 5B so that a very large number of points on a given track 120 can be examined and the slope of the points along the line detected and recorded. This step is repeated for a set of M circumferential tracks shown, for example, as 120, 122 in Fig. 5B, with the data being stored so that a sequence of points representing the slopes of a set of tracks along N radial lines indicated at 130, 132, 134 can be stored. This step is indicated at step 600 in Fig. 6. It should be noted that by rotating the disc and utilizing high speed sampling, it is possible to sample and store data for 30,000 or more radial lines.

**[0037]** As a next step 602, as indicated in Fig. 6, a circumferential averaging step is carried out. This circumferential averaging step 602 averages the measured slope at the same circumferential track for each track. This step 602 of taking a track average of an entire revolution for a track is used to obtain a representative slope of each track, tightening the variations due to local differences in a disc and providing a good